A Study of the Remote Working Efficiency in IT Project Implementation during the COVID-19 Pandemic

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Abstract: - Regarding the COVID-19 situation, the purpose of this study was to compare the efficiency and outcomes of information technology (IT) project implementation in the office versus in a remote environment with respect to factors such as productivity, effective teamwork, enjoyment of work, stress and pressure management, and opinions on working styles. The focus was mainly on the role of team members in the engineering mindset. Data was collected through a survey of IT project performance from team members. The questionnaire, which was developed for this study, included 105 respondents and was divided into three parts: 1) general information, 2) project performance results, and 3) engineering mindset concept. Quantitative data were analysed using descriptive statistics. The results of the study indicated that there are significant differences in outcomes between project managers and other team members (such as developers, business analysts, and quality assurance) in terms of the studied factors, Project managers who need to communicate and collaborate with various team members may face challenges or limitations when working remotely. On the other hand, other roles in the project team that can be completed independently and do not require frequent communication with the rest of the team may find remote work more convenient and flexible. Importantly, the survey results also demonstrated that a team member's engineering mindset is a critical factor in the success or failure of projects. Those with a strong engineering mindset tend to implement and deliver projects effectively. Therefore, IT projects are more likely to be successful when the team has a good engineering mindset.

Key-Words: -covid-19 ; project implementation; Information Technology; remote working; distance working; engineering mindset

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1 Introduction

COVID-19 has changed the world, and every industry has been affected by the change. Businesses need to change their strategies in order to survive the impact, [1]. Even the Information Technology (IT) industry, which is considered one of the industries that drive the world, has been greatly affected. From 2005 to 2020, the growth of distance work reached 159%, [2], and the number of remote jobs increased by 300% from 2014 to 2019, [3]. That is why virtual or distance work is one of the most popular topics in the era of the new normal.

Although using technology is one of the most effective solutions for surviving a crisis, the implementation of IT projects has been affected and has changed dramatically. It is a big challenge to run and implement projects smoothly, having everyone on the project team, including customers, connect and work as if in a normal situation without any repercussions. The project team needs to have special skills, techniques, tools, and a mindset in order to keep the project running smoothly.

From now on, the adoption of technology is key to success in every project. Therefore, the implementation of information technology projects is very important.

The purpose of this study was to compare the efficiency and outcomes of information technology (IT) project implementation in the office versus in a remote environment with respect to factors such as productivity, effective teamwork, enjoyment of work, stress and pressure management. The focus was mainly on the role of team members (project managers, developers, business analysts, and quality assurance) in the engineering mindset.

1.1 Information Technology Project

An information technology project is a task that is completed over a certain period of time using technology. An information technology project encompasses all aspects of the endeavor's strategy,

design, implementation, project management, and training, [4].

Tohidi, [5], conducted a study on the implementation of information technology projects and found that technology is fundamental to organizational success factors that increase competitiveness and efficiency, and productivity of work. However, it also increases the challenge of working for personnel in the organization. The project management theory and practice offer methods, tools, and techniques to support project management. In the concept phase, Feasibility is typically used to study the project, [6], the Cost Benefit Analysis, [7], is used to assess the financial analysis and economic effects of a project, [8], and the Logical Framework, [9], is used to define the project as precisely as possible and assess its benefits.

Since information technology projects are a type of project, activities related to their implementation involve the use of various resources to create works that are beneficial to the target group. These activities must be independent and able to be analysed, planned, and managed, including having clear objectives. There is a definite period of time for these activities, and operations must be within the budget in order to achieve quality work that meets the specified criteria, [10].

1.2 Defining Remote Work, Telework, Work at Home, and Home-based Work

Working from home and distance working are not new phenomena, but they have greatly increased due to the Covid-19 pandemic. This alternative may have a longer-term effect on some distinct aspects, including how people organize their work and where it is performed. It is important to clearly understand the four different concepts of remote work, telework, work at home, and home-based work, and how they relate to each other. 1) Remote work, [11], can be described as situations where work is fully or partly carried out at an alternative worksite other than the default place of work. 2) Telework, [12], is a subcategory of the broader concept of remote work and includes workers who use information and communications technology or landline telephones to carry out work remotely. 3) Work at home, [13], refers to work that takes place fully or partly within the worker's own residence, with the home serving as the physical location for all or some of the work. 4) Home-based workers, [3], are defined in the resolution concerning statistics on work relationships as "workers whose main place of work is their own home".

2 Literature Review

2.1 Advantages and Disadvantages of Distance Working

A survey of the advantages and disadvantages of working remotely in Latvia has been conducted, [14]. The results of the study are as follows: 1) Individual organization of working space - 37.47%;2) Opportunity to choose convenient equipment - 16.90%; 3) Opportunity to choose working place - 8.58%; 4) Opportunity to choose working time - 7.88%; 5) Economy of travel time to work - 6.21%; 6) Economy of travel expenses to work - 5.53%; 7) Opportunity to organize working process independently - 3.96%; 8) Opportunity to work individually - 3.31%; 9) Opportunity to work without permanent control - 3.17%; 10) Opportunity to limit distractions caused by other employees - 2.59%; 11) Opportunity to spend more time on relatives and hobbies - 2.24%; and 12) Opportunity to do something parallel during working - 2.15%.

The disadvantages of working remotely can be listed as follows: 1) Difficulty in organization of working space - 37.61%; 2) Lack of equipment - 9.66%; 3) Weak Internet signal - 6.57%; 4) Irregular work schedule - 6.32%; 5) Difficulty of performing tasks via the Internet - 5.00%; 6) Disorganized working negotiations via the Internet - 4.62%; 7) Lack of access to working information - 4.17%; 8) Lack of face-to-face communication with management - 3.43%; 9) Lack of face-to-face communication with other employees - 3.16%; 10) Lack of control by management - 2.84%; 11) Difficulty to get into working mode in the morning - 2.21%; 12) Difficulty to stop working in the evening - 2.15%; 13) Lack of environment change - 2.03%; 14) Feeling of loneliness - 1.96%; 15) Presence of distractions by family members, household issues, etc. - 1.75%; 16) Difficulty to make yourself work - 1.56%; 17) Lack of balance between work and personal life - 1.50%; 18) Lack of inspiring working atmosphere - 1.28%; 19) Informational overload - 1.14%; and 20) Communicational overload - 1.06%.

According to the research about disadvantages of distance working, it appears that it can be divided into 2 groups which are 1) Relate or Impact to the project from topics number 1 to 10 and 18, 19, 20. it is 86.85% of total topics and 2) NOT Relate or Impact the project from topics number 11 to 17 which is 13.15%. This clearly shows that project management has a significant impact on project outcomes.

2.2 Engineering Mindset

Engineering Mindset Thinking, [15], is a way of thinking that combines the problem-solving/design process with the life skills that foster dealing with others in a team. It provides the culture, measurements, feedback, planning skills, tools, and values of engineering. The engineering mindset is to define problems and provide proper solutions, design and develop innovative (adaptive) products, and seek, think, and always be curious (Learning). Mindset and Motivation are often tied to goal orientation, [16].

Marnie Jamieson and John Donald, [17], studied the relationship between engineering mindset skills and skills in Leadership and Management, both technical and non-technical, and found that people with a high engineering mindset have an emphasis on technical characteristics, communication, and teamwork. It has the potential to progress to the organizational and societal leadership development levels more than the traditional engineering approach.

Lottero and Lachapelle, [18], conducted a comparative study of the engineering mindset of fifth graders aged 10 to 11 in the United States. Using a sample of 2,086 people, three-quarters of students who received additional education in engineering skills answered a questionnaire demonstrating scores in Engineering Mindset that are clearly higher and improved academic, social, communication, and problem-solving skills. They are also better able to cope with and learn from failure than the average student group.

Cunningham, [19], examined the application of engineering concepts to science teaching (STEM) and found that students can apply engineering thinking to better solve scientific and complex problems, can analyse problems, and find ways to find more relevant and meaningful answers. From research related to Engineering Mindset, it is clear that people with a good engineering mindset tend to have better leadership, learning, adaptability, problem-solving, and collaborative abilities.

2.3 Hypothesis and the Concept Framework

The hypothesis for this study was that if the disadvantage of working remotely (86.85%) is related to project factors, and human resources are one of the most important aspects of project implementation, then the engineering mindset of the project team members/roles should have a direct impact on project efficiency and results. However, there may be various factors affecting work efficiency in remote work, such as individual factors, project factors, and other external factors. To give a clearer picture of this study, the concept framework diagram is summarized as follows.

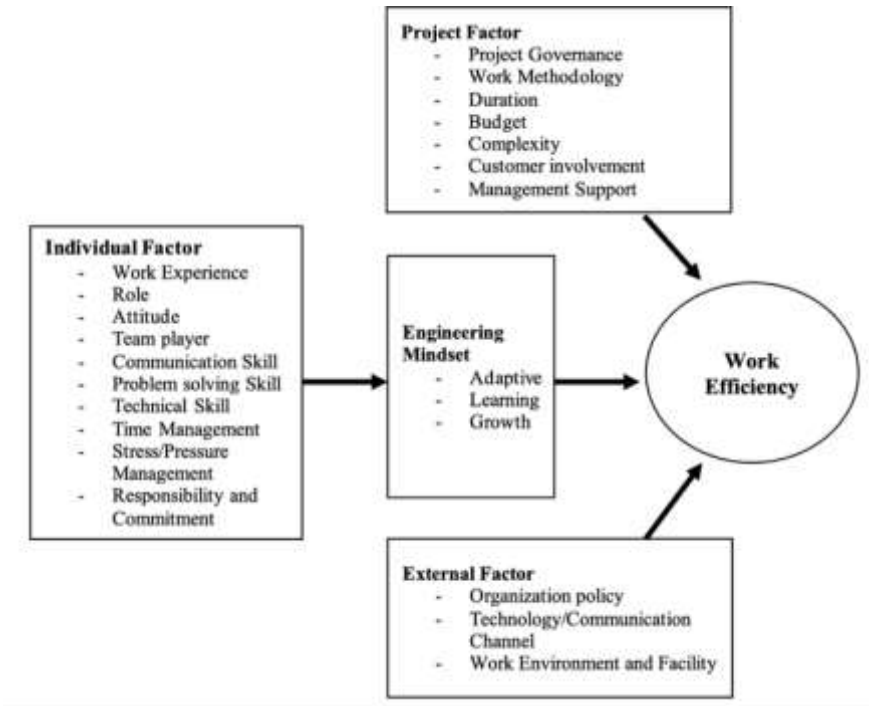

Fig. 1 : The concept framework diagram

3 Research Methodology

The survey instrument, a questionnaire developed for this study, involves 105 total respondents using a 5-point Likert scale indicating the degree of agreement where 1 is "Absolutely disagree", 3 is "Not Sure", and 5 is "Absolutely agree". The questions discussed within the questionnaire are separated into 3 parts. The first part is a respondent's profile, the second part is project experience and results during distance working, and the third part is related to the project manager's perception of the engineering mindset.

The survey instrument in the engineering mindset part was highly influenced by the work of Dr. George D. Ricco, [20]. There are questions on both the positive formulation and the negative formulation in order to test the reliability of the project team member's responses.

The samples for this survey were chosen from IT professionals who work remotely, using the specific purpose technique. The result analysis will use descriptive statistics with the mean average method to find the difference between the success and failure of the project team in terms of the engineering mindset. In addition, the standard deviation (S.D.) will be used to demonstrate the deviation of the result. From the list of questions (Appendix), it can be categorized into 3 types of mindsets [21], which are Adaptive, Growth, and Learning, as described in Table 2. From these 3 types, to ensure the reliability of a group of questions, Cronbach's alpha will be used to assess the reliability and internal consistency of a set of questions. The formula for Cronbach's alpha is:

$$\alpha = \frac{N\bar{c}}{\bar{v} + (N-1)\bar{c}}$$

Where: N is the number of items, $\bar{c}$ is the average covariance between item-pairs and $\bar{v}$ is the average variance

Table 1. Question categorization and Cronbach's alpha calculation result

Type of Mindset	Definition	Question Number	Cronbach's alpha
Adaptive	A mental attitude of assessing the facts and circumstances of the current situation and/or environment and making the appropriate adjustments to thrive in any scenario.	1,2,3,11, 13,16	0.810
Growth	An approach to life in which an individual believes that their talents, intelligence, and abilities can be developed further.	4,5,7, 8,9,12	0.826
Learning	An attitude that predisposes people to open to new experiences. There is a belief that abilities can be developed by learning and intentionally growing from experience.	6,10, 14,15	0.758

Table 2. The Cronbach's alpha interpretation, [22].

Result	Interpretation
> 0.9	Excellent
> 0.8	Good
> 0.7	Acceptable
> 0.6	Questionable
> 0.5	Poor
< 0.5	Unacceptable

4 Research Results

Survey participants who are working on an information technology project can have different roles in the project, as follows:

Table 3. Role and Percentage

Role	Percentage
Developer	28.85%
Product/Business/System Analyst	22.12%
QA, Tester	17.31%
Project Manager	14.42%
Other (IT Support, Recruiter, Top Management etc.)	17.30%

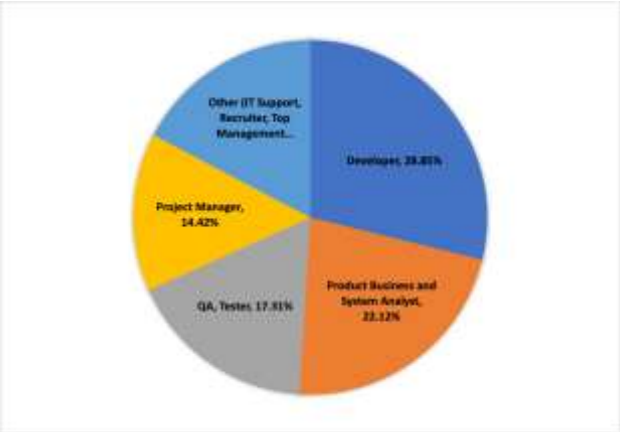

Fig. 2: Participant Role and Percentage (Table 2)

The respondents' roles can be divided into two main areas: Project Manager and Project Executor (Developer, QA, Tester, Product Business, and System Analyst). The survey found that the two groups had clearly different results in terms of work productivity, enjoyment of working, and stress and pressure management.

Table 4. Result Percentage for each topic

Topic	Measurement	PM (%)	PO/BA/SA (%)	Dev (%)	QA (%)
Productivity	Less Productivity	**57.14**	13.64	14.81	27.78
	Not sure	14.29	30.77	22.22	27.78
	More Productivity	28.57	**63.64**	**62.96**	**44.44**
Enjoyment of Working	Less Enjoy	**50**	9.09	18.52	16.67
	Not sure	28.57	30.77	14.81	22.22
	More Enjoy	21.43	**63.64**	**66.67**	**61.11**
Stress and Pressure	Less Stress and Pressure	21.43	**50.00**	**55.56**	**50.00**
	Not sure	35.71	18.19	14.82	22.22
	More Stress and Pressure	**42.86**	31.81	29.62	27.78

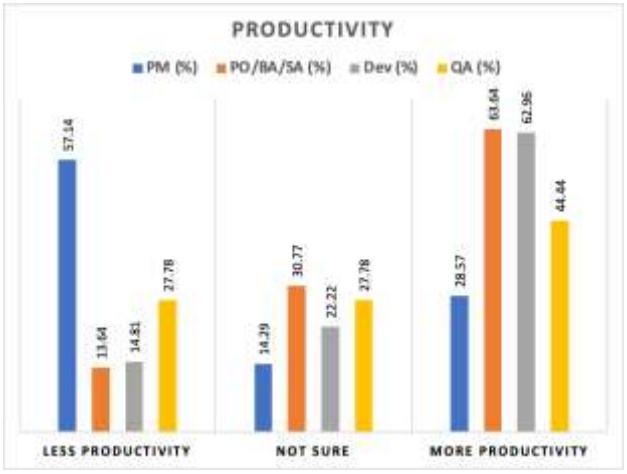

Fig. 3: Result Percentage for Productivity

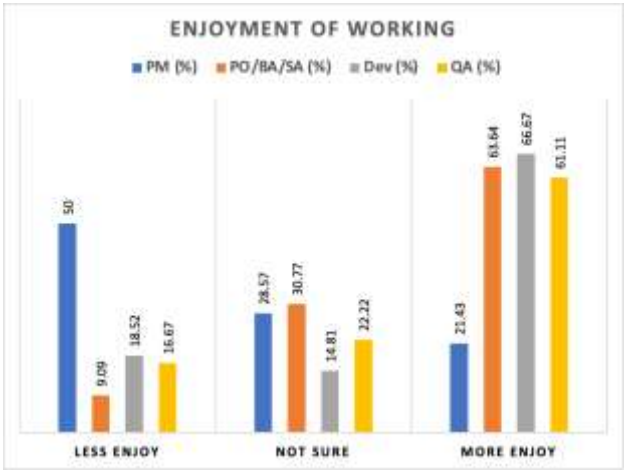

Fig. 4: Result Percentage for Enjoyment of Working

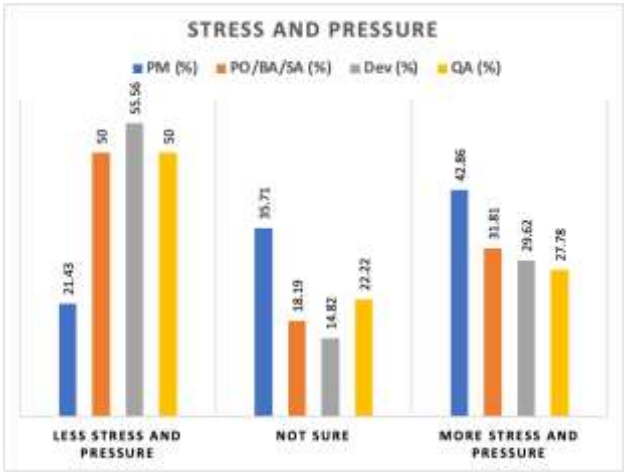

Fig. 5: Result Percentage for Stress and Pressure

Table 4 shows the percentages of responses in different categories for three topics: productivity, enjoyment of working, and stress and pressure. For each topic, the table presents the percentage of responses that fall into three categories: 'Less', 'Not sure', and 'More'. In addition, the graphs in Figures 3, 4, and 5 show the comparison among the

categories to clarify the difference in percentage for each role.

The results of the study on the engineering mindset abilities have been summarized in Table 5

Table 5. Mean average and Standard Deviation

Topic	Group	Mean	SD
The Engineering Mindset and Productivity	More Productive Group	4.01	0.76
	Less Productive Group	3.85	0.68
	Not Sure	3.74	0.72
The Engineering Mindset and Enjoyment of working	More Enjoy working Group	4.02	0.81
	Less Enjoy working Group	3.81	0.78
	Not Sure	3.64	0.67
The Engineering Mindset and Stress/Pressure Management	Good management	3.97	0.73
	Not Good management	3.82	0.78
	Not Sure	3.79	0.69

Table 5 presents the results of a study that has been conducted on the relationship between the engineering mindset and three factors: productivity, enjoyment of working, and stress and pressure management. The results show the mean and standard deviation (SD) for each group being compared within each of the three topics. There are three groups for each topic: 'More', 'Less', and 'Not Sure'.

The standard deviation (SD) is a measure of the amount of variation or dispersion in a set of data. In the table provided, the SD is given for each group in relation to three topics: the engineering mindset and productivity, the engineering mindset and enjoyment of working, and the engineering mindset and stress/pressure management.

For the engineering mindset and productivity, the group with the highest mean score (4.01) and the lowest SD (0.76) is the "More Productive Group." This suggests that this group has a relatively high level of agreement or consistency in their responses, with a relatively small range of scores. In contrast, the "Less Productive Group" and the "Not Sure" group have lower mean scores (3.85 and 3.74, respectively) and higher SDs (0.68 and 0.72, respectively), indicating a greater degree of variation or dispersion in their responses.

For the engineering mindset and enjoyment of working, the group with the highest mean score (4.02) and the lowest SD (0.81) is the "More Enjoy Working Group." This suggests a high level of agreement or consistency in their responses, with a relatively small range of scores. The "Less Enjoy Working Group" and the "Not Sure" group have lower mean scores (3.81 and 3.64, respectively) and higher SDs (0.78 and 0.67, respectively), indicating a greater degree of variation or dispersion in their responses.

For the engineering mindset and stress/pressure management, the group with the highest mean score (3.97) and the lowest SD (0.73) is the "Good management" group. This suggests a high level of agreement or consistency in their responses, with a relatively small range of scores. The "Not Good management" and "Not Sure" groups have lower mean scores (3.82 and 3.79, respectively) and higher SDs (0.78 and 0.69, respectively), indicating a greater degree of variation or dispersion in their responses.

Overall, the results in the table suggest that the group with the highest mean score and the lowest SD generally has a higher level of agreement or consistency in their responses, while groups with lower mean scores and higher SDs have a greater degree of variation or dispersion in their responses. This information can be useful for understanding the reliability and consistency of the data and for identifying potential patterns or trends in the responses.

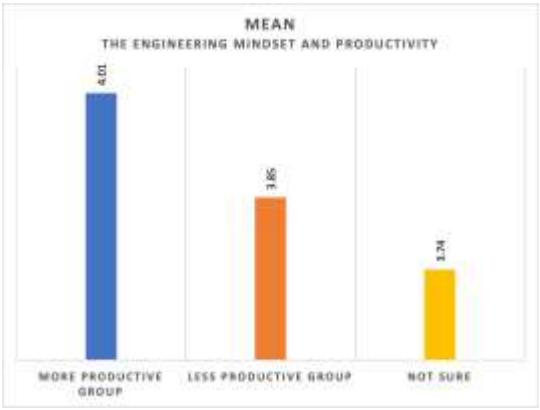

Fig. 6: Mean - The Engineering Mindset and Productivity

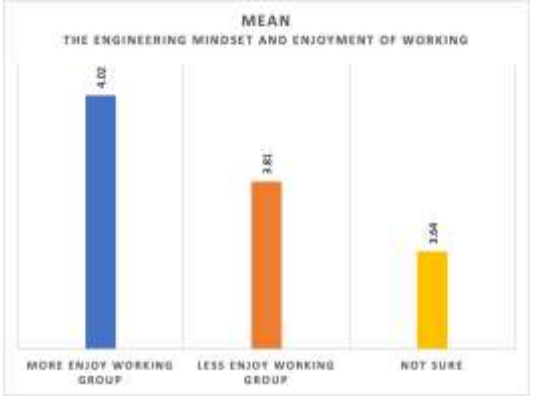

Fig. 7: Mean - The Engineering Mindset and Enjoyment of working

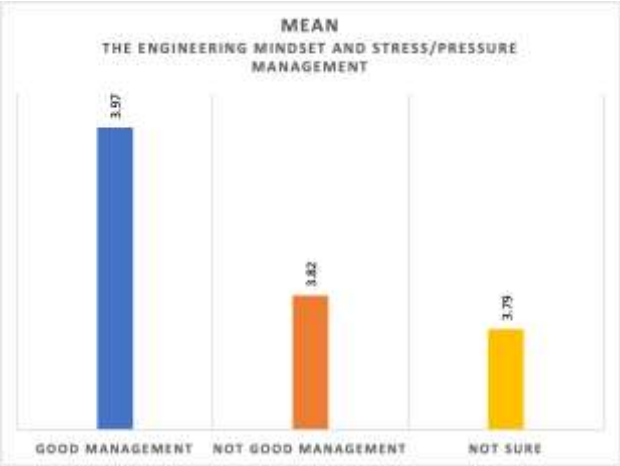

Fig. 8: Mean - The Engineering Mindset and Stress/Pressure Management

Figures 6, 7 and 8 are graphs that are presenting the results of a study that has been conducted on the relationship between the engineering mindset and three different factors: Productivity, Enjoyment of Working, and Stress and Pressure management in order to compare and clearly see the differences in each factor

5 Discussion

The results of the survey, as summarized in Tables 4 and 5, clearly demonstrate that the roles of project managers and project operators differ significantly in many dimensions. This is directly related to the way each role works. Project managers have to work with various people in the project team, which can present challenges or limitations when working remotely. On the other hand, other roles in the project team have a nature of work that allows them to work independently and do not necessarily require much contact with the rest of the team, making remote work more convenient and flexible.

In addition to this, the engineering mindset was another important factor examined in the survey. The research also examined the mindset factors of project team members in information technology projects that may impact project outcomes, focusing on the engineering mindset. According to the survey results, an engineering mindset is directly correlated with work efficiency. Respondents who received high scores had a positive effect on remote work, meaning they were suitable for and capable of working well in a remote environment. This is consistent with research by Cunningham, [19], Marnie Jamieson and John Donald, [17], and Lottero and Lachapelle, [18], which shows that individuals with a strong engineering mindset have a positive impact on activities. This group of respondents is a valuable asset to the project and organization, [23]. On the other hand, respondents with low scores had a negative effect on remote work, meaning they may be more suitable to work in an office or face-to-face environment.

Moreover, another interesting thing is that respondents answered: "Not sure". One possible explanation for the relationship between having a "Not sure" response and lower engineering mindset scores is that those who are unsure may be less confident in their decision-making abilities or may feel that they need more guidance from their supervisor. This lack of confidence or reliance on others for guidance could indicate a need for improvement in adaptive or learning skills. This group of respondents could be a valuable sample to consider in future studies on engineering mindset development, as they may have specific areas of improvement that can be targeted through training or other interventions.

It is also possible that those who answered "Not sure" may have less experience or knowledge in the specific subject matter being addressed, leading to a lower engineering mindset score. In this case, it may be beneficial to consider providing additional resources or support to help build their confidence and knowledge base.

Overall, the relationship between having a "Not sure" response and lower engineering mindset scores warrants further investigation and consideration in future studies on engineering mindset development. Understanding the specific needs and challenges faced by this group can help inform more targeted and effective interventions for improving engineering mindset and decision-making abilities.

6 Conclusion

Remote or distance working is the new standard in today's work environment, so it is important for everyone to adapt and learn, especially in the implementation of information technology projects. However, the research's results show that remote work has limitations and is not suitable for all roles in the project. It can be seen that the roles of project managers and operators (Developers, QA, BA, etc.) are clearly different due to their different nature and work styles. The project manager needs to be in close contact with the team for the most efficient work, so working in a remote manner is a limitation and an obstacle to work. It is therefore imperative for project managers to adapt and learn work methods to meet the changing environment and maintain the quality of work. While other roles in

the project have a nature of working in their area of responsibility or having little contact with others, there are fewer problems and obstacles in remote operations. Combined with other external factors such as commuting, time management, or work-life balance, it can lead to more time to focus on work, making work efficient and leading to a desire to continue working in the remote working model.

In addition, the survey of an engineering mindset, when analysed together with the efficiency and results of remote work, found that a group of people with higher Engineering Mindset scores were more likely to be able to work on remote projects more efficiently than those with lower scores on average.

Overall, the results of this research study suggest that remote working can be a successful and effective model for many roles in information technology projects. Many individuals in the study reported that they enjoyed the benefits of remote work, such as the ability to focus on work and improve work-life balance, and expressed a desire to continue working in this way.

However, it is important for organizations to carefully consider the suitability of remote work for each role in the project. The study found that project managers may face challenges when working remotely due to the need for close contact with the team, and it may be necessary for them to adapt and learn new work methods to overcome these challenges. From the results clearly show that project managers with high scores on the engineering mindset have good results on projects. This suggests that having a strong engineering mindset is crucial for project managers working in a remote environment to effectively manage the project.

Therefore, it is important for organizations to consider the engineering mindset of project managers when deciding whether to implement a remote working model for a particular project. By doing so, management can help to ensure that remote projects are well-managed and efficient, and that team members are able to work effectively and achieve positive outcomes.

Additionally, the implementation of information technology projects in a remote environment requires that all project members have a strong skill set in order to adapt to changing situations and learn and apply new things to increase efficiency. The engineering mindset is an important skill that can enhance the capabilities of project team members. Consequently, the management can consider the engineering mindset of team members as a factor when deciding whether to implement a remote working model for a project or use the engineering mindset as a policy to determine whether team members are allowed to work onsite or remotely in a given project.

Hence, it is an interesting topic to explore the most efficient techniques for building, improving, and evaluating the engineering mindset of project team members, which can also be applied to other human resources to improve the success rate of projects.

Apart from that, some other interesting factors need to be investigated more closely and considered in further studies, such as the educational level, certificate, or previous work experience of team members. In addition, there may be many factors in the context of the project that affect the performance and outcomes of project implementation, such as team-specific skills, high-level management support, technology, or the organization's policy. These may be part of the considerations for further research in the future.

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Appendix

The questions on the survey related to the project team member's mindset

No.	Positive (P) or Negative (N)	Question
1	N	You have a certain amount of intelligence, and you really can't do much to change it
2	N	Your intelligence is something about you that you can't change very much.
3	P	No matter who you are, you can significantly change your intelligence level
4	N	To be honest, you can't really change how intelligent you are
5	P	You can always substantially change how intelligent you are
6	N	You can learn new things, but you can't really change your basic intelligence
7	P	No matter how much intelligence you have, you can always change it quite a bit
8	P	You can change even your basic intelligence level considerably
9	N	You have a certain amount of talent, and you can't really do much to change it
10	N	Your talent in an area is something about you that you can't change very much
11	P	No matter who you are, you can significantly change your level of talent
12	N	To be honest, you can't really change how much talent you have
13	P	You can always substantially change how much talent you have
14	N	You can learn new things, but you can't really change your basic level of talent
15	P	No matter how much talent you have, you can always change it quite a bit
16	P	You can change even your basic level of talent considerably